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FE analysis of the T-profile for airplane door

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This paper deals with the replacement of the titanium profile in the airplane door with the composite one. The aim of the project is the FEM analysis of the titanium T-profile integrated in airplane door and to design a composite part which will be lighter and stiffer. It is obvious that the design will change the shape of the cross-section of the T-profile. The connecting dimensions have to remain the same. So, several ways were chosen to examine the stiffness of the titanium and composite T-profile.

First the titanium T-profile was analyzed in the FEM model. The profile was loaded by single unit forces in the directions of the axes of the coordinate system that was connected with the T-profile the same way in all analyzed cases. Than the two different composite versions of the profile were designed.

The models of the titanium and CFRP profiles have the same composition. The T-profile with the fixed coordinate system was placed on the flat composite plate which was the same for all three cases. This plate presents the attachment in the real position of the profiles. The profiles were fixed by screws, so this connection was modeled by the tie interaction. Than the models with the clamped T-profiles were realized to get the comparison of the profiles stiffness and to see the effects of the flat composite plate on the profiles deformation. The comparison of the deformation could be seen in the Fig.1.

titanium T-profile	composite variant 1	composite variant 2

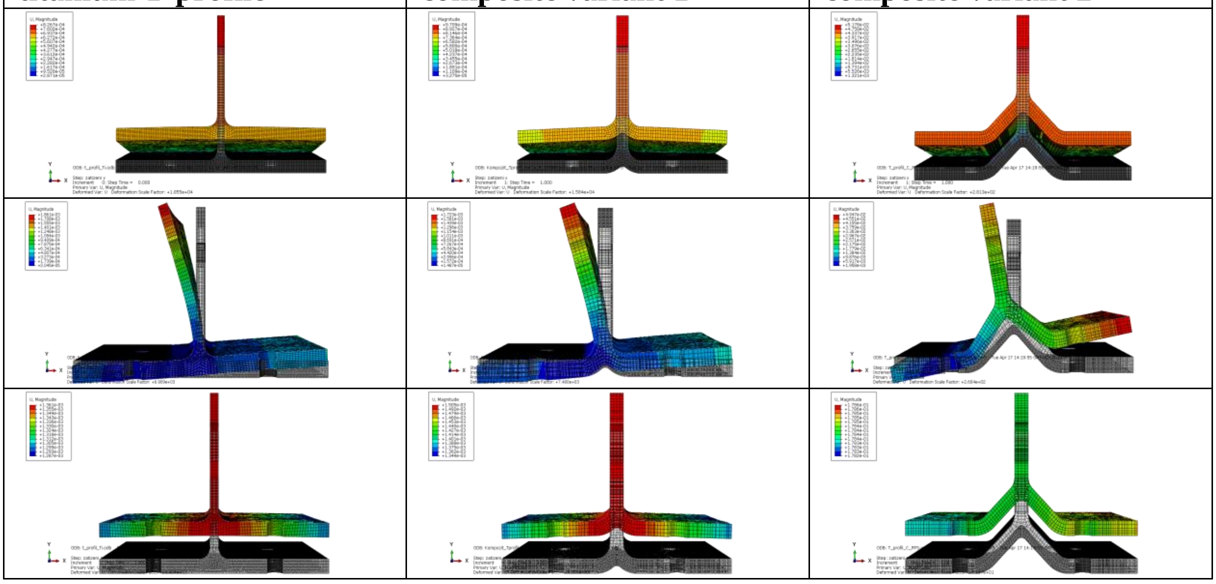

Fig. 1. The versions of the T-profile and their loading

The material constants were calculated as orthotropic homogeneous material using rule of mixtures with respect to fiber undulation (5H satin weave). The effective constants from this previous calculation are used as inputs to the FEM model. The CFRP T-profiles were modeled as volume model and the effective material constants were used. This way of modeling represents the whole volume of the model, but it allows the parametric inputs of the materials constants for orthotropic material. This is a simplification of the FEM modelling of a composite material parts.

The models were done with respect to the composite layup of the T-profiles. So, the profile was divided to some parts representing the layup composition with the same characteristic. Then the material constants with their own coordinate system for each separate part of the T-profile were assigned. The elements C3D8R were used for meshing in Abaqus [1].

The results for all three cases of T-profiles can be seen below in Fig. 2 and Fig. 3. There is a big decrease in the displacement in all directions especially for the second version of the composite T-profile. Both composite versions are stiffer than the titanium one. The maximal displacement can be seen in all cases in the direction of the *y* axis, but it is known that this direction is not so important in the real loading of the T-profiles. The most important for the real load is the decrease of the displacement of the second composite version in the direction of the *z* axis.

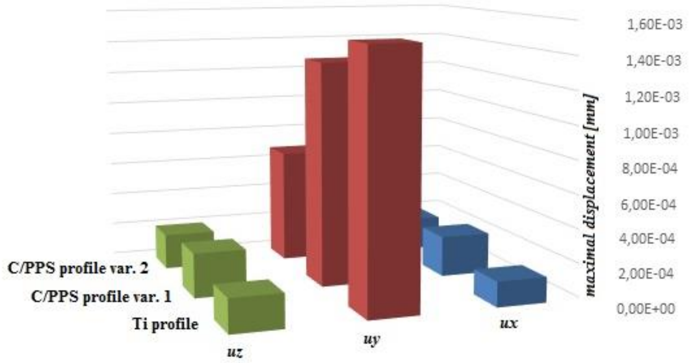

Fig. 2. Comparison of displacements for all cases of T-profiles fitting on the flat composite plate

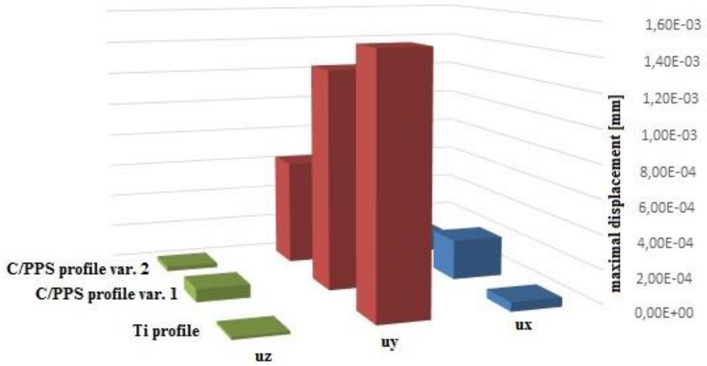

Fig. 3. Comparison of for all cases of clamped T-profiles

Acknowledgements

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References

[1] Smith, M., ABAQUS/Standard User's Manual, Version 6.14. Providence, RI: Simulia, 2014.